Environmental profiles of construction materials, components and buildings for the UK

ENVIRONMENTAL PROFILES OF CONSTRUCTION MATERIALS, COMPONENTS AND BUILDINGS FOR THE UK.

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A Life Cycle Assessment (LCA) methodology for construction products has been established with UK construction materials producers. The method provides "level-playing field" LCA for all types of construction materials. Environmental Profiles provide a consideration of materials as part of building elements, including maintenance and replacement. A software tool called ENVEST™ uses this data to analyse the whole building. This gives the impact of the structure and operational impacts of a design over a set lifetime, in UK Ecopoints. The use of Ecopoints for life cycle assessment results enables environmental issues to be integrated into life cycle design alongside financial costs.

1 INTRODUCTION TO ENVIRONMENTAL PROFILES

Environmental Profiles are a method of presenting environmental data to cut through the confusion of claims and counterclaims about the performance of building materials.

They allow designers to demand reliable and comparable environmental information about competing building materials, and give suppliers the opportunity to present credible environmental information about their products.

The growing demand for environmental information had resulted in an uncoordinated range of life cycle assessment approaches to different building materials. The problem was that there had been no standard assessment method.

Comparing different products is difficult when there is no way of knowing if the assessment methods used in each case have considered the same factors - for example, is the information based on typical practice? Does the information make predictions about recycling? Is transport included (and return journeys)? Differences between such details can make comparisons of information from different sources meaningless.

1.1 A level playing field

What was needed was a standard UK method of applying LCA to construction products, which BRE developed in a three-year project supported by the construction materials industry and UK Government.

The result has been the publication of a set of common rules and guidelines for applying LCA to create Environmental Profiles of UK construction products [1], and a UK database [2] to create a one-stop-shop for environmental information provided by industry.

The standardised method of identifying and assessing the environmental effects of building materials over their life cycle - extraction, processing, use and maintenance, and their eventual disposal - means that designers can have confidence in the "level playing field" status of Environmental Profiles for every material type. BRE and the Steering Group of materials industry representatives believe that this method represents the most objective and workable approach that could be developed to deal with *all* building materials.

1.2 Inputs and outputs

Environmental Profiles can be provided in two ways –

as raw "inventory" data of inputs and outputs:

□ Material use	□ Emissions to air
□ Water use	□ Emissions to water
□ Embodied energy	□ Emissions to land

and as environmental impact indicators caused by the inputs and outputs:

□ Climate change	□ Water pollution: Eco-toxicity
□ Acid deposition	□ Water pollution: Eutrophication
□ Ozone depletion	□ Minerals extraction
□ Fossil fuel depletion	□ Water extraction
□ Air Pollution: human toxicity	□ Waste disposal
□ Air Pollution: low level ozone creation	□ Transport Pollution and Congestion

1.3 Elements and materials

Cradle to grave Environmental Profiles are calculated for building elements (walls, floors, roofs, etc) with a 60 year lifetime. This anticipated lifetime is needed to allow maintenance, replacement and disposal factors can be taken into account.

In addition, profiles can be calculated for building elements as they are installed in to the building, these being limited to *cradle to installation* assessments. They are for use by designers who have specific life information about the elements - for example, an element may be in a building designed to have a life span of just 20 years.

Element Profiles are assessed on a per-square-metre basis so that the quantities of different materials needed to produce the same functional building element can be compared - for example the mass of steel and the mass of aluminium needed to produce a square metre of wall cladding.

Profiles are also calculated for building materials (steel, aluminium, concrete, etc). Materials profiles are presented on a per tonne basis, and the environmental impacts considered are those occurring from *cradle to factory gate*. Materials profiles are used to provide the "building blocks" of the elements. They may also be used in future to compare, for example, two equivalent products from competing manufacturers.

1.4 Future development

The methodology must continue to be developed and improved. While it currently focuses on environmental impacts (from energy, minerals and water consumption, and waste, air and water emissions - these being the impacts most relevant to construction materials) the long-term aim of this work is to comprehensively account for all key parameters of environmental, economic and social impact. Other issues, notably landuse and biodiversity, may be added to future editions as the methodology evolves.

The development of the LCA methodology is a significant milestone on the route to providing materials users with meaningful guidance on choosing sustainable design options. Construction professionals may use the methodology and resultant environmental profiles in different ways and BRE is using the data in a range of applications. The data provides an update to simple handbooks such as The Green Guide to Specification [3], which gives A, B, C ratings for different building elements. The methodology has determined the basis for environmental declarations by materials producers or third party certification. The data is also available in a software tool, called ENVEST™ [4].

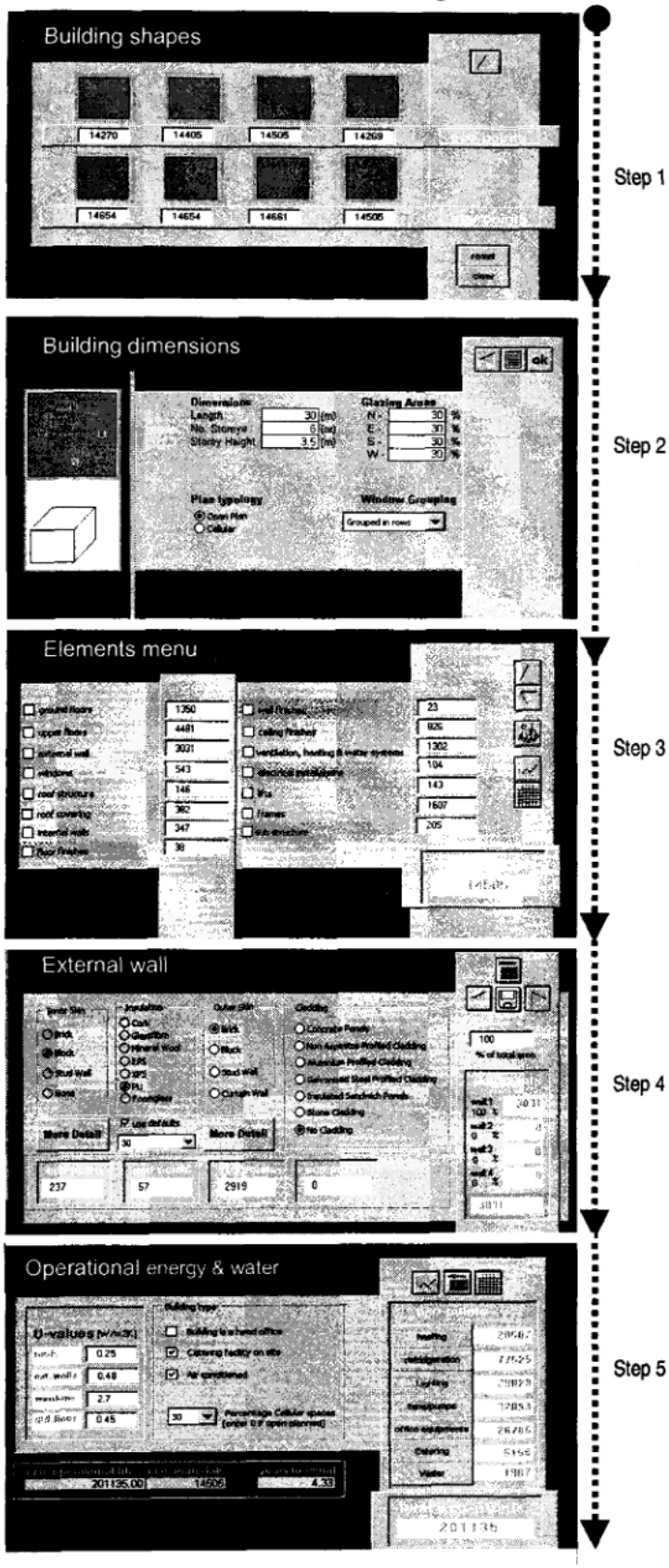
2 SOFTWARE APPLICATION: ENVEST

The LCA information as Environmental Profiles is valuable but it is not easy to use. Therefore, BRE has developed ENVEST, the environmental impact estimation tool. This software allows designers to use Environmental Profiles information to consider the life cycle environmental impact of building materials whilst they are at the building inception stage. It provides a holistic approach to design by:

- helping to optimise the form of the building, for the least environmental impact

- informing choice about the environmental impacts of the main elements of the building structure
- providing and maintaining reference data acquired from material manufacturers
- helping designers to balance the environmental impact of the energy and water consumed during the operational life of the building, with the choice of building materials

performing comparisons of various building schemes.



ENVEST™ is the first UK software for estimating the lifecycle environmental impacts of a building from the early design stage. This version is for office buildings, and considers the environmental impacts of:

1. materials used during construction;
2.the energy and water consumed over the building's life.

Using minimal input data ENVEST™ allows designers to instantly identify those aspects of the building which have the greatest influence on the overall impact.

All environmental impacts are measured on a single points scale called 'Ecopoints' allowing the designer to compare different designs and specifications directly. These are described below.

2.1 A tour through ENVEST ™

The procedure for obtaining an environmental appraisal of the building is very simple. [Fig. 1]. Almost all data entry is from menu choices, which remove the need to look up U values, building regulation requirements etc.

Step 1 requires the designer to select a building shape from a choice of eight generic shapes.

Step 2 is to input basic building dimensions and details-such as storeys and window area.

Steps 3 and 4 are to enter the details of main building elements, which are all presented as menu choices. It is possible to refine the design by experimenting with different specifications to see how this affects the Ecopoint score.

Step 5 is to enter details for the building services e.g. heating, lighting, air conditioning, which enables the software to estimate the operational impacts.

At the end of this procedure, the user can examine the final 'Ecopoints' score and compare with previous designs they may have entered. Various comparison graphs can be made, both within one design and between two designs. This may cover the contribution of different building elements to the overall Ecopoint rating, the ratio of material impact to operational impact and different aspects of the building design as percentage of overall Ecopoint rating [fig.2]. The impact of the two designs can be compared as a breakdown of the different elements and as their contribution to the environmental impacts arising from each design.

2.2 Influence of the design life.

The environmental impact of a building is greatly influenced by the length of its useful life and the same applies to its individual elements. ENVEST™ uses built-in values for the life of building elements and has a default value for the expected life of the whole building. The user can also enter the building's life.

Fig.1: basic steps through ENVEST™
[These Screens are representations only]

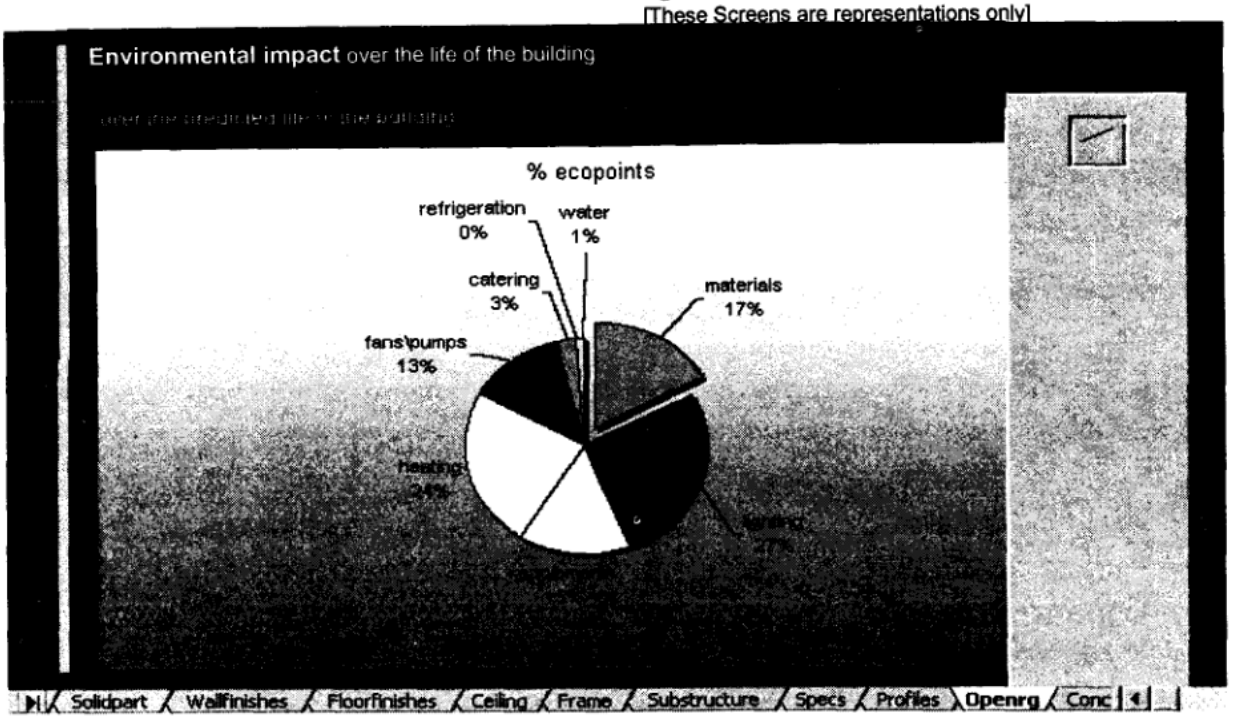


Fig.2 Output: Environmental impact over the life of the building

3 ECOPOINTS

Ecopoints have been developed to allow different environmental impacts to be added together and compared, on a single scale [fig.3].

In order to do this, a weighting system was developed to allow the relative importance of different environmental issues to be established. This was achieved by carrying out consensus based research across a broad range of interest groups in the UK construction industry. Representatives from central and local government, developers, construction professionals, academics, materials producers and environmental activists were asked to rank environmental issues according to their importance. The resulting "weights" are used to provide information on the relative performance

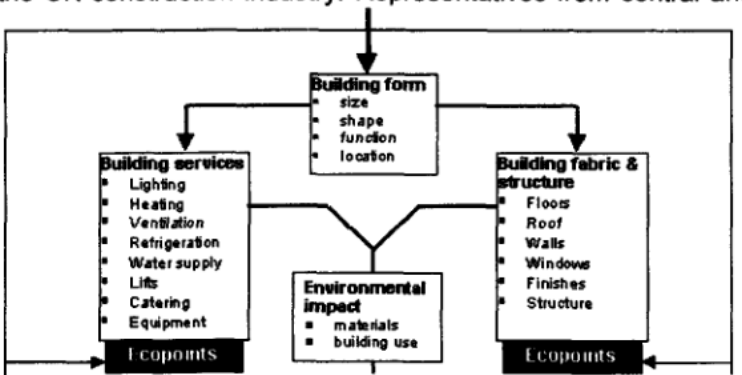
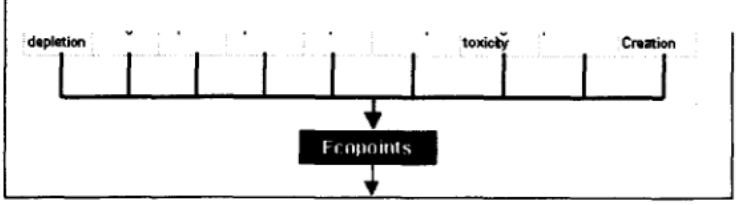


Fig. 3: Schematic sketch of the method to derive the ecopoints for a building design

4 INTEGRATING LCA AND WLC/LCC FOR INTEGRATED LIFE CYCLE DESIGN

Owner-occupiers and companies who design, build and operate buildings for a client are increasingly interested in minimising the whole life financial costs of a building. This process is variously



known as Whole Life Costing (WLC) and Life Cycle Costing (LCC). Environmental life cycle impacts are also, less often, recognised as an important dimension of "life cycle costing" but this is often seen as an issue too complex to incorporate. A recent workshop at BRE with local government, social housing providers and materials producers highlighted the need to have a simple environmental index to allow environmental life cycle issues to be integrated with life cycle costing. The use of Ecopoints is an elegant solution to this requirement and allows decision-makers to see the trade-offs they are making in their design choices. When costs are mapped against ecopoints for a particular design choice, the decision-maker can see the environmental benefits to be gained from choosing a particular option. In this way, for example, expenditure can be targeted towards design options where perhaps a little expenditure results in the greatest environmental benefits rather than choosing more expensive items that also provide an environmental saving but which results in less environmental savings per unit of cost.

The combination of different tools described above has been developed to inform different decision makers, thus allowing them to choose to use either the most simplified set of information or undertake their own LCA according to an industry agreed methodology

5 REFERENCES

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